CLAIMS

1. An optical device with first and second inputs, comprising:

a first coupler coupled to the first input and producing at least a first and second output;

a second coupler coupled to the second input and producing at least a first and second output;

a third coupler coupled to the first output of the first coupler and to the first output of the second coupler;

a fourth coupler coupled to the second output of the first coupler and to the second output of the second coupler;

first and second crossing waveguides with an angle selected to minimize crosstalk and losses between the first and second cross waveguides,the first crossing waveguide connecting one of the first or second outputs from the first coupler with an input of the fourth coupler, the second crossing waveguide connecting one of the first or second outputs from the second coupler with an input of the third coupler;

a first phase shifter coupled to the first and second waveguides, the first and second waveguides connecting one of the outputs of the first or second coupler and one of the inputs of the third or fourth couplers, wherein the first, second, third and fourth couplers, the two crossing waveguides and the phase shifter are each formed as part of a single planar chip made of an electro-optical material.

2. The optical device of claim 1, wherein the optical device is a free-space optical link device.

3. The optical device of claim 1, wherein the optical device is an optical pointing device.

4. The optical device of claim 1, wherein the optical device is a tracking device.

5. The optical device of claim 1, wherein the chip is a single piece of crystal.

6. The optical device of claim 1, wherein the chip is made of $LiNbO_3$ or $LiTaO_3$.

7. The optical device of claim 1, wherein the chip is made of $LiNbO_3$ or $LiTaO_3$ cut at X, or Y, or Z planes.

8. The optical device of claim 1, wherein the first coupler is a Y-junctions.

9. The optical device of claim 1, wherein the second coupler is a Y-junctions.

10. The optical device of claim 1, further comprising:

a second phase shifter coupled to the first and second waveguides, the first and second waveguides connecting one of the outputs of the first or second coupler and one of the inputs of the third or fourth coupler.

11. The optical device of claim 1, wherein the first, second, third and fourth couplers are 3-dB devices.

12. The optical device of claim 1, wherein the chip is a two-layer structure.

13. The optical device of claim 1, wherein an output power splitting ratio from the first, second, third and fourth couplers is independently adjustable.

14. The optical device of claim 1, further comprising:

first, second, third and fourth biased electrodes. is coupled to the first, second, third and fourth couplers respectively.

15. The optical device of claim 1, wherein the first biased electrode is coupled to the first coupler, the second biased electrode is coupled to the second coupler, the third biased electrode is coupled to the third coupler, and the fourth biased electrode is coupled to the fourth coupler.

16. The optical device of claim 15, wherein the first, second, third and fourth couplers, the first and second crossing waveguides are formed in a first layer, and the first, second, third fourth biased electrodes and the first and second phase shifters are formed in an adjacent second layer.

17. The optical device of claim 14, wherein the each of the first, second, third and fourth couplers have electrode geometries with alternating polarity.

18. The optical device of claim 17, wherein the first, second, third and fourth electrodes are split into an even integer number of sections to provide voltages that have a reversed polarity at each section.

19. The optical device of claim 14, wherein each of the first, second, third and fourth electrodes are push-pull electrodes.

20. The optical device of claim 1, wherein each of the first, second, third and fourth electrodes are configured to optimize a splitting operating point of the first, second, third and fourth couplers.

21. The optical device of claim 20, wherein each of the first, second, third and fourth electrodes optimize the splitting operating point by splitting an output power ratio of the first, second, third and fourth couplers.

22. The optical device of claim 1, wherein the first phase shifter is adjustable.

23. The optical device of claim 1, further comprising:

a second phase shifter..

24. The optical device of claim 23, wherein the second phase shifter is adjustable.

25. The optical device of claim 14, wherein the first phase shifter includes a phase-shifting electrode..

26. The optical device of claim 23, wherein the second phase shifter includes a phase-shifting electrode.

27. The optical device of claim 1, wherein the electro-optical material is a ferroelectric material.

28. The optical device of claim 27, wherein the ferroelectric material is selected from $LiNbO_3$ and $LiTaO_3$.

29. The optical device of claim 1, wherein the electro-optical material is a semiconductor material.

30. The optical device of claim 29, wherein the semiconductor material is selected from Si and InP.

31. The optical device of claim 1, wherein the optical device is made utilizing indifussed metal technology.

32. The optical device of claim 1, includes the optical device is made utilized protonic-exchange technology.

33. The optical device of claim 1, wherein the optical device is made utilizing etching technology.

34. The optical device of claim 1, wherein the optical device is made utilizing milling technology.

35. The optical device of claim 1, wherein the optical device is made utilizing CVD technology.

36. The optical device of claim 1, further comprising:

a substrate.

37. The optical device of claim 36, wherein the substrate is coated with a buffer layer.

38. The optical device of claim 37, wherein the buffer layer is silicon dioxide.

39. A method of transmission, comprising:

providing an optical device with first, second, third and fourth couplers, the two crossing waveguides and the phase shifter are each formed as part of a single planar chip made of an electro-optical material; and

applying a voltage to the first, second, third and .fourth couplers to maintain a desired power splitting ratio.

40. The method of claim 39, wherein the optical device includes at least one phase shifter.

41. The method of claim 40, further comprising

applying offset voltages to the phase shifter to maintain a desired phase relationship between in-phase and in-Quadrature electrical signals at an output of the optical device.

42. The method of claim 40, wherein the optical device includes a second phase shifter.

43. The method of claim 42, further comprising:

controlling the first and second phase shifters to provide a desired phase relation of in-phase and Quadrature signals.

44. The method of claim 40, further comprising,

optimizing an average optical power at outputs of in-phase and in-quadrature signals.

45. The method of claim 41, wherein the optical device includes a feedback control loop.

46. The method of claim 45, further comprising:

producing a voltage control signal and utilizing the feedback control loop to control the first, second, third and fourth couplers and the first phase shifter.

47. The method of claim 45, wherein the optical device includes a processing device that samples averaged in-phase and in-quadrature signals.

48. The method of claim 46, further comprising:

producing an error signal from sampling of the averaged in-phase and in-quadrature signals..

49. The method of claim 44, wherein the optical device includes a converter device.

50. The method of claim 49, further comprising:

utilizing the converter device to provide rates that are at least equal to a bandwidth of a signal when averaging of data and processing is performed digitally.

51. The method of claim 39, wherein the transmission is in free space.

52. The method of claim 39, wherein the transmission is with a fiber.

53. The method of claim 39, wherein the transmission is applied to a ladar application.

54. The method of claim 39, wherein the transmissionis utilized for spectral analysis.

55. An optical communication system, comprising:

a transmitter; and

a receiver, the receiver including:

a first coupler coupled to the first input and producing at least a first and second output;

a second coupler coupled to the second input and producing at least a first and second output;

a third coupler coupled to the first output of the first coupler and to the first output of the second coupler;

a fourth coupler coupled to the second output of the first coupler and to the second output of the second coupler;

first and second crossing waveguides with an angle selected to minimize crosstalk and losses between the first and second cross waveguides,. the first

crossing waveguide connecting one of the first or second outputs from the first coupler with an input of the fourth coupler, the second crossing waveguide connecting one of the first or second outputs from the second coupler with an input of the third coupler;

a first phase shifter coupled to the first and second waveguides, the first and second waveguide being connected to one of the outputs of the first or second coupler and one of the inputs of the third or fourth coupler, wherein the first, second, third and fourth couplers, the two crossing waveguides and the phase shifter are each formed as part of a single planar chip made of an electro-optical material.

56. The system of claim 55, wherein the transmitter comprises:

a first Mach-Zehnder modulator that produces a first output;

a second Mach-Zehnder modulator that produces a second output;

a splitter coupled to the first and second Mach-Zehnder modulators;

a combiner that combines the first and second outputs; and

a phase shifter coupled to the first and second Mach-Zehnder modulators, wherein the first Mach-Zehnder modulator, the second Mach-Zehnder modulator, the splitter, the combiner and the phase shifter are formed as part of a single planar chip made of electro-optical material.

57. The system of claim 56, wherein the single planar chip is a single piece of crystal.

58. The system of claim 56, wherein the chip is made of a material selected from $LiNbO_3$ or $LiTaO_3$.

59. The system of claim 56, wherein the chip is made of $LiNbO_3$ or $LiTaO_3$ cut at X, or Y, or Z planes.

60. The system of claim 56, wherein the splitter is a Y-junction.

61. The system of claim 56, wherein the splitter is a waveguide coupler.

62. The system of claim 56, wherein the combiner is a Y-junction.

63. The system of claim 56, wherein the combiner is a waveguide coupler.

64. The system of claim 56, wherein the first Mach-Zehnder modulator includes a first biasing electrode, and the second Mach-Zehnder modulator includes a second biasing electrode.

65. The system of claim 56, further comprising:

a first bias electrode coupled to the first Mach-Zehnder modulator; and

a second bias electrode coupled to the second Mach-Zehnder modulator.

66. The system of claim 65, wherein each of the first and second bias electrode is a push-pull configuration.

67. The system of claim 65, wherein the first and second bias electrode are configured to optimize a DC bias point of the first and second Mach-Zehnder modulators

68. The system of claim 56, wherein the splitter is adjustable.

69. The system of claim 56, wherein the combiner is adjustable.

70. The system of claim 56, wherein each of the first and second Mach-Zehnder modulators is a push-pull configuration.

71. The system of claim 56, wherein the splitter is positioned at an input of the system, and the combiner is positioned at an output of the device.

72. The system of claim 56, wherein the splitter and combiner are 3-dB devices.

73. The system of claim 56, wherein each of the first and second Mach-Zehnder modulators is driven by an RF signal.

74. The system of claim 56, wherein the system includes at least a first and a second waveguide each associated with one of the first and second Mach-Zehnder modulators.

75. The system of claim 56, wherein the waveguides of the first and second Mach-Zehnder modulators are coplanar to each other.

76. The system of claim 56, further comprising:

a phase shifter with a third bias electrode coupled to each of the first and second Mach-Zehnder modulators and configured to provide an adjustable 90° phase difference between outputs from first and second Mach-Zehnder modulators.

77. The system of claim 76, wherein the phase shifter is a push-pull configuration.

78. The system of claim 56, wherein the splitter divides an input beam into substantially equal first and second beams that are directed to the first and second Mach-Zehnder modulators.

79. The system of claim 56, wherein each of the first and second Mach-Zehnder modulators are independently modulatable.

80. The system of claim 56, wherein the electro-optical material is a crystal made of a material selected from $LiNbO_3$ or $LiTaO_3$, with a cut at X, Y, or Z planes relatively to an axis of the crystal.

81. The system of claim 56, wherein indifussed metal technology is used with the electro-optical material includes.

82. The system of claim 56, wherein protonic-exchange optical technology is used with the electro-optical material includes.

83. The system of claim 56, wherein etching optical technology is used with the electro-optical material.

84. The system of claim 56, wherein milling optical technology is used with the electro-optical material.

85. The system of claim 56, wherein the electro-optical material includes a substrate coated with a buffer.

86. The system of claim 57, wherein the buffer is silicon dioxide.

87. The system of claim 55, further comprising:
a multiplexer coupled to the transmitter and receiver.

88. The system of claim 55, further comprising:
an optical repeater coupled to the transmitter and receiver.

89. The system of claim 55, further comprising:
an amplifier coupled to the transmitter and receiver.

90. The system of claim 55, further comprising:
a filter coupled to the transmitter and receiver.

91. The system of claim 55, wherein the transmitter comprises:
a first Mach-Zehnder modulator that produces a first output;
a second Mach-Zehnder modulator that produces a second output;

a third Mach-Zehnder modulator that produces a third output;

a fourth Mach-Zehnder modulator that produces a fourth output;

a first input splitter coupled to the first and second Mach-Zehnder modulators;

a first phase shifter coupled to the first and second outputs;

a first output combiner positioned to combine the first and second outputs from the first and second Mach-Zehnder modulators;

a second input splitter coupled to the third and fourth Mach-Zehnder modulators;

a second phase shifter coupled to the third and fourth outputs; and

a second output combiner positioned to combine the third and fourth outputs.

92. The optical device of claim 91, wherein the first, second, third and fourth Mach-Zehnder modulators, the first and second input splitters, the first and second phase shifters, and the first and second input splitters are formed as part of a chip made of electro-optical material.

93. The optical device of claim 91, further comprising:

a third input splitter coupled to the first and second input splitters.